**HERBAL BIOMEDICINES AND THEIR ROLE IN SUSTAINABLE AQUACULTURE**

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**ABSTRACT**

Aquaculture has been considered as one of the most rapidly animal food-producing industries that provide to the world’s well-being and wealth. Medicinal plants have been known as immunostimulants for thousands of years. Globally, people understand the adverse effects of antibiotics and are now shifting to natural products. Many herbal and animal originated extracts prove their potential as anti stress, antioxidant, antibacterial, anti fungal and viral, appetite stimulator, potent immunomodulator and growth promoter. They reduce the chances of emergence of pathogens which may cause serious threat to fish health and environment. Yet the diseases, pathogens and pest can be treated with chemicals and antibiotics, but due to their residual side effect and bio magnification in the body of fish force the researchers to search suitable alternatives for healthy fish, environment and sustainable fish production. Herbal compounds such as phenolics, polyphenols, alkaloids, quinones, terpenoids, lectines and polypeptides have been shown to be very effective alternatives to antibiotics and other synthetic compounds.

**Keywords:** Antioxidant, Anti stress, Antiviral, Appetite Stimulants,Growth promoter,Immunostimulants

**Introduction**

Nutrition and health management play a key role for a successful aquaculture. Intensive exploitation of capture fishery resources has lead to almost stagnation in its production. There is a wide gap between the capture fish production and the ever increasing demand for fish. Hence, aquaculture is considered as one of the better alternative means to meet the demand and potential area to tackle the challenges of food security, economy and employment.

Antibiotics and chemotherapeutics are common agents used to handle the outbreak of those diseases in aquaculture. However, the application of these prophylactics leads to the emergence of antimicrobial resistant bacteria and adverse impacts on the water environment. (Done *et al.*,2015). Supplementation of natural prophylactics is considered as promising preventive practice which assists in maintaining fish welfare, and a healthy environment (Bruce, Brown, 2017; Guardiola *et al*., 2016). Among them, medicinal plants have been considered as promising one. Plant products have been widely applied in aquaculture to enhance growth performance, immune system and to provide antioxidant effects due to their biological compounds such as alkaloids, terpenoids, saponins and flavonoid elements (Reverter *et al*., 2017).

Moreover, dietary inclusion of plant products can reduce the risks associated with antibiotics and chemotherapeutic and be considered as one of the most effective means for diseases resistance prevention in aquaculture (Nayak, 2010). Thus, there is a rising trend in use of natural products in recent decades with a focus on medicinal plants as an alternative to antibiotics.

**Biomedicines commonly used in aquaculture**

Aquaculture has been considered as one of the most rapidly animal food-producing industries that provides to the world’s well-being and wealth (Edwards *et al.,* 2019). The rapid development of aquaculture and intensification has led to the stressful condition and consequence of the outbreak of diseases (Kennedy *et al.,* 2016).

The use of antibiotics and chemotherapeutics for prophylaxis and treatment in intensive aquaculture has been widely criticized for their negative impact (FAO, 2003). Interest in the use of immunostimulants as an alternative to the drugs, chemicals and antibiotics currently being used to control fish diseases is growing, partially because immune stimulants in contrast to vaccines enhance the innate or non-specific immune response (Galeotti, 1998; Sakai, 1999).

Medicinal plants have been used as an immunostimulants for thousands of years (Tan and Vanitha, 2004). The application of medicinal plants as natural and innocuous compounds has potential in aquaculture as an alternative to antibiotics and immune prophylactics. In aquaculture, medicinal plants are also used as chemotherapeutics and feed additives (Chang, 2000). Several plants or their byproducts contain phenolic, polyphenolic, alkaloid, quinone, terpenoid, lectine and polypeptide compounds which are effective alternatives to antibiotics, chemicals, vaccines and other synthetic compounds (Harikrishnan *et al*., 2011).

Many studies showed that inclusion of herbs in fish diet has positive effect on growth and disease resistance. The addition of herbs and herbal products in fish diet is cheaper and environmental friendly with low side effect to the fish and consumers. Plant extracts are known to promote growth, stimulate appetite, enhance tonicity and immunostimulation, facilitate maturation of cultured species and possess stress reduction, sexual stimulation and antipathogenic properties in fish (Reverter *et al.,* 2014). There are various reports of herbal fish diets promoting growth performance (Ji *et al*., 2007; Dada, 2012), increasing stress tolerance (Ji *et al*., 2009) and enhancing immune system efficiency (Dügenci and Candan, 2003; Dügenci *et al*., 2003; Bai *et al*., 2009).

The use of antibiotics in shrimp hatcheries has resulted in tissue biomagnification that in turn leads to rejection of the total consignment during export. The Marine Product Export Development Authority(MPEDA) of India has instructed hatchery operators and farmers not to use antibiotics such as chloramphenicol, nitrofurans (including furazolidone, nitrofurazone, furaltadone, nitrofurantoin, furylfuramide, nifuratel, nifursoxime, nifurprazine and all their derivatives), neomycin, nalidixic acid, sulphamethoxazole and related formulations, chlorpromazine, colchicine, dapsone, dimetridazole, metronidazole, ronidazole, ipronidazole and other nitroimidazoles, clenbuterol, diethylstilbestrol, sulfonamide (except approved sulfadimethoxine, sulfabromomethazine and sulfaethoxyrpyiadine), floroquinolones and glycopeptides. Many of these are currently used in hatcheries and farms (Sananda kumar, 2002).

Globally, people understand the adverse effects of antibiotics and are now shifting to natural products (Fauci, 1993). The practice of herbal medicine dates back to the very earliest period of known human history. There is evidence of herbs having been used in the treatment of human diseases and for revitalizing body systems in almost all ancient civilizations (Aftab and Sial, 1999). Active components of herbal medicine could enhance nutrient digestibility, absorption and assimilation capacity by enhancing the digestive enzymes secretion and maintaining healthy intestinal microflora as well as improving immune status (Mohiseni *et al*., 2017). Moreover, high content of natural antioxidant in herbal medicine as flavonoids, tocopherols, cinnamic acid and folic acid carotenoids can obstruct reactive oxygen species (ROS) generation and scavenge free radicals from tissues (Citarasu, 2010; Astuya *et al*., 2017).Plants and their extracts can act as enhancers of the immune system (Hernández-Contreras and Hernández,  [2020](https://link.springer.com/article/10.1007/s10695-021-00952-7#ref-CR63)), providing a more natural and environmentally friendly alternative to counteract infectious diseases instead of using antibiotics and synthetic substances.

**Importance of herbal biomedicines in aquaculture**

**Herbal drugs act as immunostimulants**

An immunostimulant is a chemical, drug, stressor or action that enhances defense mechanisms or immune response. When an immunostimulant is given as dietary supplement, it can improve the innate defense of animals which will provide them resistance against pathogen infection. Phagocytic activity, NBT, myeloperoxidase and serum lysozyme are important parameters that provide information on the non-specific defense mechanisms in fish. In the study conducted by YIN *et al*. (2006), Phagocytic and lysozyme activities were increased when *Astragalus* radix extract was added to the feeds of tilapia (*Oreochromis niloticus).* In another study, resistance to the increase in NBT, lysozyme, Phagocytic activities were observed when *Astragalus* and *Lonicera* extracts added to tilapia (*Oreochromis niloticu*s) fish feeds (Ardo*et al.,* 2008).

Alambra *et al*., 2012 studied that immunomodulatory potential of turmeric (*Curcuma longa*) on *Macrobrachium rosenbergii* against *Vibrio alginolyticus*.Arulvasu *et al*. (2013) observed that efficacy of different dietary doses of *Zingiber officinale* powder for the immune response and the disease resistance of the Indian major carp (*Catla catla*) infected by *Aeromonas hydrophila*. The total erythrocyte, leukocyte count, haemoglobin content and total serum protein were significantly (P<0.05) enhanced in *Z. officinale* supplemented groups.

Glycyrrhizin is a glycosylated saponin containing one molecule of glycyrretinic acid, which has anti-inflammatory and anti-tumour activities, mediated by its immunomodulatory activities (Wada *et al*., 1987; Zhang *et al., 1990*). However, Kim *et al.* (1998) reported that in vitro treatment with glycyrrhizine enhanced the respiratory burst activity of macrophages and the proliferative responses of lymphocytes from rainbow trout. Few studies demonstrated that lysozyme activity was induced by black cumin in rainbow trout (Celik Altunoglu *et al.,* 2017), and dill (*Anethum graveolens*) and garden cress (*Lepidium sativum)* in common carp (*Cyprinus carpio*) (Bilen *et al.,* 2018). Aline Brum *et al.* (2017) reported that the supplementation with 1.0% clove basil provided the lowest values of hematocrit and the highest numbers of neutrophils at 35 days.Lymphocyte values were lower in fish fed 1.0% and 1.5% ginger as well as 0.5% basil. Barroso *et al*. (2014) also observed a reduction in lymphocytes in sole (*Solea senegalensis*) fed probiotics and challenged with *Photobacterium damselae*.

Similar to several studies in which lysozyme activity was enhanced in Indian major carp, *Labeo rohita* fed aloin (Srivastava *et al.,* 2018); common carp, *Cyprinus carpio* fed rosemary leaf powder (Yousefi *et al*., 2019); zebrafish, *Danio rerio* fed ginger powder (Ahmadifar *et al.*, 2019) and in rainbow trout, *Oncorhynchus mykiss* fed Aloe vera, *Stachys lavandulifolia*and *Coriandrum sativum* (Mehrabi *et al*., 2019; Naderi Farsani *et al*., 2019; Sarvi Moghanlou *et al*., 2018). It is wellestablished that the dietary intake of *Origanum vulgare* leaf extracts and fenugreek seeds stimulates the serine peroxidase activity in gilthead seabream (Beltrán *et al*., 2018; Guardiola *et al*., 2018).

Naphakorn Srichaiyo *et al.* (2020) reported that thedietary administration of 5 and 10 g kg−1 gotu kola powder was significantly stimulated the phagocytic ability in comparison with the control treatment. An increase in respiratory burst was found in sea bream, *Sparus aurata* and European sea bass, *Dicentrarchus labrax* (Bilen *et al*., 2019; Fazio *et al*., 2017) and Nile tilapia (Doan *et al*., 2019).Farsani*et al*. (2019) reported that *O. mykiss* fed on a diet supplemented with 2% coriander seed extract for 8 weeks have significant stimulation to serum total immunoglobulin (IgM), total serum protein, and globulin, which possesses a wide spectrum of biological functions in fish.The Zebrafish fed 20 g/kg coriander powder showed remarkably increased mucosal immune parameters (Total immunoglobulin, protease and lysozyme activity) and significant higher expression gene for lysozyme, interleukin-1-beta (IL1B), insulin-like growth factor-1 (IGF 1) and tumor Necrosis Factor alpha (TNFα) (Safari *et al.,* 2019).

**Herbal drugs act as growth promoter and appetite stimulants**

Researches on the aquaculture sector have revealed that medicinal plants are effective on the growth parameters in fishes (Rao*et al.,* 2006; Palacios*et al*., 2006 and Aly*et al*., 2008). More recently such applications have begun to demonstrate positive effects in feeds for various fish species including African catfish, (*Clarias gariepinus)* (Turan and Akyurt, 2005; Turan and Çek, 2007), rainbow trout (*Oncorhynchus mykiss*) (Bilen and Bulut, 2010; Bilen and Bilen, 2012; Cagıltay *et al*., 2011), tilapia *(Oreochromis aureus)* (Turan, 2006), (*Oreochromis niloticus*) (Rawling *et al*., 2009), common carp (*Cyprinus carpio*) (Turan and Cek, 2007) and crayfish (*Astacus leptodactylus*) (Turan *et al.,* 2012). Studies on the fish species of tilapia (*Oreochromis niloticus*) and common carp (*Cyprinus carpio*) revealed that the *Quillaja saponin* plant added to the feed reduced the feed conversion ratio while increasing protein efficiency ratio, apparent lipid utilization, apparent energy utilization and specific growth rate (Francis*et al.,* 2001; Francis*et al.*, 2002a and Francis*et al*., 2002b).The herbal plants, which were used in aquaculture studies, are a lot and several such as *Coriandrum sativum* (Ahmed *et al*., 2020), *Curcuma longa* (Kumari and Paul, 2020), *Zingiber officinale* (Fazelan *et al*., 2020), *Rosmarinus officinale* (Naiel *et al*., 2020), and *Allium cepa* (Akrami *et al*., 2015).

Matheus D *et al*. (2019) demonstrated that the Nile tilapia fed diets containing 400, 800, and 1200 mg vegetable choline /kg of feed presented an augmentation on live weight, weight gain, corporal length and feed intake after 60 days.Luo *et al.* (2016) reported that supplementation with 1156.4 mg of vegetable choline kg of feed increased weight gain, specific growth rate and feed intake of yellow catfish (*Pelteobagrus fulvidraco*) after 60 days.Esin Baba *et al.* (2017) reported that the Nile tilapia were fed with food, including 0.5%, 1% and 2% argan oil for 45 days. Results showed that in both pre-challenge and post-challenge periods, the argan oil was able to stimulate some parameters on the non-specific immune system in Nile tilapia. It also improved the growth performance and survival rate against *Lactococcus. garvieae.*Farsani *et al.* (2019) recorded a significant increase in specific growth rate and final weight of *Oncorhynchus mykiss* fed for 8 weeks on diets supplemented with 2% coriander seed extract (CSE).Anle Xu*et.al.* (2020) documented that the Chinese herbal medicine mixture could significantly influence *L. japonicus* growth performance with the FCR decreased and FW, WG and SGR increased in 20 g/kg Chinese herbal medicine mixture group.

Hassan *et al.* (2018) reported that the 1% rosemary supplementation significantly increased weight gain, SGR and protein efficiency ratio but had an insignificant effect on carcass composition of Nile tilapia (*Oreochromis niloticus*). Safari *et al.* (2019) reported that *Ferula asafoetida* could improve Koi carp (*Cyprinus carpio koi*) growth performance in 20−25 g/kg ferula powder diet. Hien Van Doan *et al*. (2019) determined that the dietary supplement of 5 g kg−1 *E. scaber* significantly improved the WG and SGR of Nile tilapia, while concurrently reducing FCR.Aline Brum *et al.* (2017) reported that the supplementation with essential oil of clove basil has improved the feeding conversion ratio and weight gain at 0.5% in Nile tilapia *(Oreochromis niloticus).*Among the bay laurel extract-supplemented groups, the African catfish fed diet with 1.5% bay laurel extract exhibited significantly higher growth than fish fed diets with 0.5, 1% and control groups (Funda Turan *et al*., 2016).

Majid M. *et al*. (2018)results revealed that highest daily growth rate and highest specific growth rate were achieved common carp fed diet 2% bay laurel extract than fish fed with 1%, 3% and control groups.Mohsen Ali *et al.* (2017) results revealed that addition of ajwain and marjoram extracts at 1–2% could significantly increase (P <.05) some growth factors, including BWI, SGR, FCR, LG and CF as well as reduce economic conversion ratio (ECR) in rainbow trout after active feeding.The application of 0.2% soaked seed of ajwain could improving nutrient absorption enhancing gut micro-flora and increasing digestibility as an alternate to antibiotic growth promoters in diet of broiler (Amar Shroha *et al.,* 2017). Etyemez Büyükdeveci *et al.* ([2018](https://link.springer.com/article/10.1007/s10695-021-00952-7#ref-CR41)) studied the impact of using diets with garlic extract to feed the rainbow trout (*Oncorhynchus mykiss*), finding that the weight gain and the specific growth rate of the fish were significantly improved when the fish consumed the diets containing garlic.

Various plant extracts from herbs and spices improve animal performance by stimulating gut secretions or by a direct bactericidal effect on gut microflora. The active components of herbs in diets induce the secretion of digestive enzymes. For example, a hot spice from peppers (such as capsaicin and piperine) and other essential oils (such as cinnamon, which supplies cinnamaldehyde) stimulates amylase production. Reducing the amount of undigested material limits the substrate available for proliferation of pathogenic bacteria. The growth promoter characteristic of herbals induces transcription leading to increased protein synthesis.Venkatramalingam K *et al.,* 2007 found that Shrimp post larvae (PL) have shown improved digestive enzyme activity (amylase, protease, and lipase) when fed with Artemia enriched with herbal appetizer (*Z. officinalis*).Lee MC *et al*. (2013) reported that diet supplemented with 1% of ethanolic katuk extract (*Sauropus androgynous*) resulted in increased appetite, growth and improved food utilization (lower feed conversion ratio) in grouper *Epinephelus coioides.*

**Herbal drugs act as antioxidant properties**

Antioxidants help organisms deal with oxidative stress caused by free radical damage. Free radicals are chemical species that contain one or more unpaired electrons causing them to be highly unstable and damage other molecules by extracting electrons from them to attain stability. A wide variety of chemical compounds found in plants possess antioxidative effects which help organisms deal with oxidative stress caused by free radical damage, hence, improve the general physiological condition of fish (Ali *et al*., 2008; Chakraborty and Hancz, 2011).

Some compounds in basil (*Ocimum*) possess strong antioxidant activity (Middleton and Kandaswami 1993). Cinnamon has antioxidant activity comparable to that of the synthetic antioxidant *butylated hydroxytoluene* (BHT) (Middleton and Kandaswami 1993). Wu *et al.*(2007) observed that the effects of *Astragalus membranaceus, Portulaca oleracea, Flavescent sophora* and *A. paniculata* on stress resistance and immunological parameters of *Cyprinus scarpio.* The result showed that herbal extracts acted as an antistress and inducer to serum lysozyme activity, superoxide dismutase (SOD), Nitric oxide synthase (NOS), levels of total serum protein, globulin and albumin of fish.

Hiam Elabd *et al.* (2016) reported that thesuperoxide dismutase (SOD) and Catalase activities(CAT)were significantly decreased, whileGlutathione peroxidase(GPx) andLipid peroxidase(LPx)activities were significantly elevated in response to 1- week starvation*of Astragalus membranaceus* and liquorice in yellow perch (*Perca flavescens).* Zahran *et al.* (2014) who showed that dietary supplementation of *Oreochromis niloticus* with Astragalus polysaccharidesupregulated SOD and GPx activities.

Eman M. Moustafa*et al.* (2020) revealed that the lowerMalondialdehyde(MDA) and higher SOD and GPx activities in fish fed with fenugreek indicated reduced cell damage compare to Nile tilapia fed control diet. Mohsen Abdel *et al*. (2018) evoked that dietary cinnamon nanoparticleshad antioxidant activity where MDA level and activities of SOD and CAT increased significantly, whereas GPx decreased significantly in Nile tilapia, *Oreochromis niloticus*fed cinnamon nanoparticlesenriched diets.Supplementation with 200 mg lemongrass and 400 mg geranium/ kg−1 diet resulted in an obvious elevation of both enzymatic (CAT) and Reduced glutathione nonenzymatic (GSH) antioxidants with a significant decline in the MDA level in Nile tilapia (Al-Sagheer *et al*., 2017). Wang *et al*. (2018) who demonstrated that the antioxidant ability of Japanese seabass, *Lateolabrax japonicus* improved by Chinese herbal medicines mixture supplementation expressed by the higher CAT, SOD and total antioxidant capacity (T-AOC) activities.Nazeri *et al.* (2017) observed the highest CAT enzyme activity of *Oncorhynchus mykiss* when fed diet containing rutin.Antioxidant gene expression such as SOD and CAT in common carp fed diet supplemented with palm fruit extracts were higher than control diet (Hoseinifar *et al*., 2017b).

Mohamed S. Hassaan. (2019) documented that the total antioxidant capacity, SOD and CAT were gradually increased with increasing *Silybum marianum* level in Nile tilapia diets.Sevdan Yilmaz.(2018) reported that the serum SOD and CAT increased with the addition of blackberry syrup and antibiotic in Nile tilapia.

**Herbal drugs act as antistress activity**

Bio-active compounds present in herbal extracts inhibit the generation of oxygen anions and scavenge free radicals. Herbal formulations claimed to enhance physical endurance; mental functions and non-specific resistance of the body have been termed adaptogenic. Safer and cheaper herbal medicines are useful as antistress agents because animals can withstand stress without altering physiological functions. Various herbs, *Withinia somnifera, Emblica officanalis, Asparagus racemosus, Ocimum sanctum, Tribulus terresttris* and *Piper longum*are claimed to have adaptogenic, anabolic effects and the ability to improve vital energy. The herb *Picrorhiza kurroa* is used as an antistress compound for shrimps and its effect is similar to that of superoxide dismutase, metal-ion chelators and xanthine oxidase inhibitors.(Citarasu*et al.,* 1998). Rutin is a bioflavonoid extracted from *Toona sinensis* with strong antioxidant and antistress activity in crustaceans. Rutin has improved the biochemical, immunological and haematological response to stress in *Litopenaeus vannamei* caused by *Vibrio alginolyticus* (Hsieh *et al.* 2008).Wu G *et al*., 2007 reported the Common carp (*Cyprinus carpio)* fed with diet containing 0.3 g/kg Qompsell extract reduced the stress and induce the immunological parameters such as serum lysozyme activity, superoxide dismutase (SOD), nitric oxide synthase (NOS) and levels of total serum protein, globulin, and albumin. Chinese medicinal herbs *A. membranaceus* and *L. japonica,* at 0.1% separately and together with and without boron 0.05% in diet has improved the non-specific immune response in Nile tilapia (*O. niloticus*) when challenged with *A. hydrophila*  (Ardo L *et al.,* 2008)

*Tinospora cordifolia* (Guduchi) is well known anti stress hern in ayurveda (Mittal *et al*., 2014). Liu *et al*. (2012) suggested the effects of anthraquinone extract and emodin from *Rheum officinale* on the physiological response, disease resistance of *Megalobrama amblycephala* under high temperature stress. The use of clove oil is well established to reduce stress during handling, transport and confinement (Castro et al., 2008; Otero-Ferrer et al., 2010; Pawar et al., 2011).Jeyagoby Balamuruga*et. al*., (2015) recommended the role of clove extract as an effective replacement to safely induce anesthesia, ensuring total recovery post-treatment.Xie*et.al.* (2008) reported that dietary anthraquinone extract (1%–2%) mitigated the adverse effects of crowding stress in common carp.Researchers demonstrated that in freshwater shrimp *M. rosenbergii*, anthraquinone extract improved the capacity resist to high temperature and *Moringa oleifera* leaf extract improved the anti-ammonia stress capacity. (Liu B, X *et al*., 2008; Kaleo IV *et al.,* 2019)

**Herbal drugs act as antiviral agent**

Several plant products have potent antiviral activity against fish and shrimp viruses. . Methanol extracts of five different herbal medicinal plants, such as *Cynodon dactylon*, *Aegle marmelos, Tinsospora cordifolia, Picrorhiza kurroa* and *Eclipta alba*, were incorporated into a diet for WSSV-infected shrimp. In other studies, intramuscularly injected, or orally administered aqueous extract of Bermuda grass (*C. dactylon*) to *P. monodon* displayed no mortality against WSSV whereas 100% mortality was observed in control group(Balasubramanian*et. al.,* 2007). Indian traditional medicinal plants such as *A. marmelos, C. dactylon, L. camara, M. charantia and P. amarus* showed strong antiviral activity against WSSV in *P. monodon* (Balasubramanian .*et. al.,* 2007).Micol V *et al.* (2005) reportedthe extracts of olive tree leaf (*Olea europaea*) had antiviral properties against VHSV infected carp EPC (*Epithelioma papulosam cyprini*) cell lines.Among the plants, the aqueous extract of *C. dactylon* showed strong antiviral activity at the concentration of 100 mg kg-1 of animal body (Balasubramanian *et al.*, 2007).The herbal active compounds may inhibit or block the transcription of the virus to reduce the replication in the host cells and enhance the non-specific immunity. They act as immunostimulants to the host immune system.Different ethanolic and methanolic herbal extracts are rich in several bioactive compounds that can inhibit or block the viral mRNA synthesis to reduce the replication in the host cells and enhance the non-specific immunity.Methanolic extracts of the herbs *Aclypha indica,C. dactylon,P. kurooa*, *W. somnifera* and *Z. officinalis* had effectively suppressed the WSSV after the injection with the herbal extracts and WSSV-incubated mixture. (Yogeeswaran 2007).Harikrishnan *et al.* (2010a) demonstrated that herbal leaf extract of *Punica granatum* resulted in the enhancement of innate immune responses and diseases resistance against lymphocystis viruses in Olive flounder, *Paralichthys olivaceus.*The active compounds from medicinal plants inhibit transcription of virus, reduce its replication in the host cell and thus increase innate immune response of the host (Syahidah *et al.,* 2015). The immersion of herbal solution (AquaHerb©) at 20 mg/l provides resistance against iridovirus infection in Tiger grouper, *Epinephelus fuscoguttatus* (Novriadi and Haw, 2015).Among the literature, the antiviral activity of the plant was evaluated in the form of extract, fraction and compound. (Zitterl *et al*., 2020).

**Herbal drugs act as antifungal activity**

Herbal plant extracts affect lysis of fungal cell walls, alter membrane permeability, affect metabolism and protein synthesis, ultimately leading to death. Hashemi *et.al.,* 2011 found that ethanol extracts of common rue (*Ruta graveolens*) had antifungal effects and prevented the growth of *Saprolegnia sp*. Chitmanat *et al*. (2005a) found that extract of Indian almond leaves (*T. catappa*) has potentiality to reduce the fungal infection of tilapia eggs.Ali, Enas M. (2013) studied the phytochemical composition, antifungal, anti aflatoxigenic, antioxidant, and anticancer activities of *Glycyrrhiza glabra* L. and *Matricaria chamomilla* L. essential oils

A study by Xue Gang H*et al*.(2017) showed that 10 plant species used in traditional Chinese medicine have strong inhibitory effect on fungal species like *Saprolegnia* and *Achlya klebsiana*. The petroleum ether extracts of conidium fruit (*Cnidium monnieri)*, magnolia bark (*Magnolia officinalis*) and aucklandia root (*Aucklandia lappa*) displayed best antifungal activity. Another study Wu ZF*et al.* (2011) found that ethanol extracts of common rue (*Ruta graveolens*) had antifungal effects and prevented the growth of *Saprolegnia* sp. while the red algae *Asparagopsis taxiformis* showed antifungal activity against Aspergillus species (Genovese *et al.,*2013).HUANG *et al.* (2015) reported that use of Magnolia (*Magnolia officinalis*) and Euphorbiaceae (*Euphorbia fischeriana Steud*.) forms strongest antifungal effect against *Saprolegnia* sp.

**Herbal drugs act as aphrodisiac**

Herbal biomedicines are also known to have potential hormonal boosting. Babu. (1999) concluded that the black tiger shrimp fed a maturation diet containing *W. somnifera, Mucuna pruita, Ferula asafoetida* and *Piper longum* extracts had increased fecundity and gonadal weight and reduced intermolt periods compared to controls. Researcher has observed that *Asparagus racemosus* in combination with 5% rice bran promoted the reproduction and other sexual parameters in *A. franciscana*(Devi L. 1995).Study performed by Lin˜a´n-Cabello *et al*. (2004) on Cray fish (*Cherax quadrucarinatus*) that feeding Cray fish with plant carotenoidsvegetable oils and vitamin A resulted in inducing maturation. Retinol palmitate had the greatest inductive effect on the primary vitellogenic phase and on indicators of ontogenic oocytes development.Citarasu T. (2010). Suggested that reprotism a herbal product have shown increased reproductive performance in *Artemia franciscana*.

**Conclusion**

The herbal biomedicinal active principles in the aquaculture that have the characteristics of growth promoting ability, tonic to improve the immune system, antimicrobial capability, stimulating appetite and antistress characteristics due to the active principle natures such as alkaloids, flavanoids, pigments, phenolics, terpenoids, starch, steroids and essential oils will be of immense use in the culture of shrimps. This practice will reduce the side effects of applying the synthetic compounds and the cost and also make it eco-friendly. Hence, the alternative herbal biomedicines prove to be very effective in aquaculture operations. It is evident that the application of herbal extract is promising in different aspects of aquaculture including disease prevention, treatment and stimulating the growth performance.

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